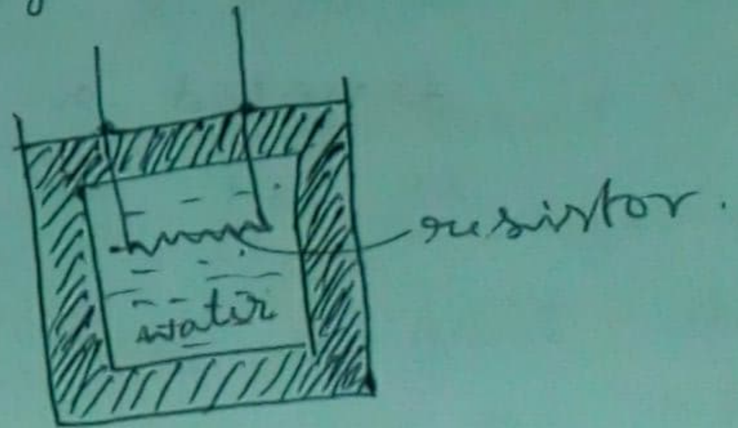
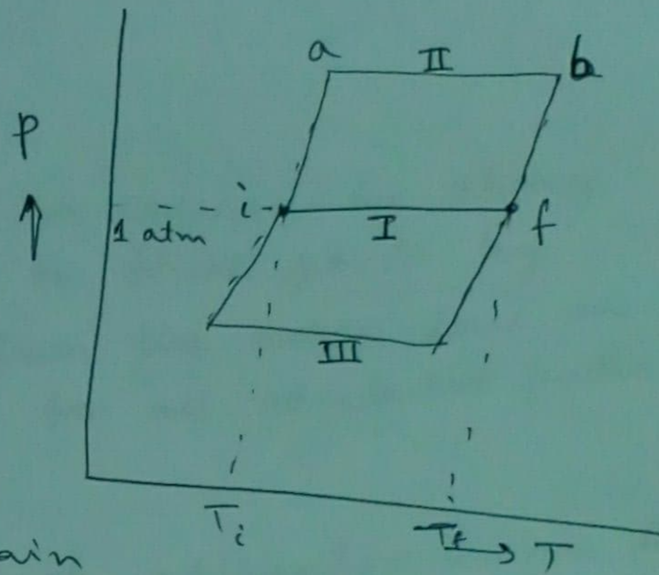
Adiabatic work:~

Let us consider a closed system completly surrounded by an adiabatic wall and still the system is coupled to the surroundings so that work may be done. Consider a composite electrical system composed of a resistor immersed in water. The initial state is characterized by the thermodynamic coordinates (P_i, T_i) $P_i = 1$ atm and $T_i = 287.7$ K (14.5°c) and the final state characteri



zed by the co-ordinates $P_f = 1$ atm and $T_f = 288.7$ K (15.5°C)



To take the system from i to f ~~thro~~ by performing ~~via~~ adiabatic work only through path I, it is necessary to pass current for certain interval of time through the water when it is maintained at one atmospheric pressure.

But path I is not the only way to take the system from state i to f using adiabatic work. The same change can take place via path II also where system is first compressed from i to a, then current is ~~pas~~ passed and then b to f it is again ~~compressed.~~ expanded. Or, we might use a similar adiabatic path III. There are an infinite number of paths by which a system may be transferred from an initial state to a final state by the performance of adiabatic work only. The adiabatic work is the same along all such paths, i.e. adiabatic work is path independent.

So, if a closed system is caused to change from an initial state to final state by adiabatic means only, then the work done on the system is the same for all adiabatic paths connecting the two states.

This path independence of adiabatic work helps ~~exists~~ to draw an important conclusion that there will must exists an energy function which depend only on the thermodynamic coordinates of the system like the gravitational potential energy in mechanics (this is function of the position coordinates of the system) or the electrical potential energy in ~~electro~~ electricity. This energy function is called internal-energy function and usually denoted by U. So, we have

$$W_{i \to f}(\text{adiabatic}) = U_f - U_i,$$ where the signs are such that if positive work is done on the system, U_f will be greater than U_i. This internal energy function is a function of thermodynamic

variables. The physical interpretation of the difference $U_f - U_i$ is the increase in internal energy of the system. It states that there exists an energy function whose difference between the two ~~val~~ values is the energy change of the system.

For a closed hydrostatic system, the equilibrium states can be completely determined by ~~any~~ any two of the three thermodynamic variables p, V, T. The third is fixed by the equation of state. ~~p, V, T.~~ The internal energy function U can be regarded as a function of any two only out of the three variables. One should ~~remember~~ remember that it may not always be possible to write internal energy function in simple mathematical form, especially when one deals with real systems.

If two states of a system differs infinitesimally, then the infinitesimal change in internal energy is denoted by dU. dU is an exact differential since it is the differential of a state function. So, the integral of dU is independent of the path between the initial and final states. In the case of hydrostatic system, if U is regard as a function of T and V, then

$$U = U(T, V)$$

$$\Rightarrow \quad dU = \left(\frac{\partial U}{\partial T}\right)_V dT + \left(\frac{\partial U}{\partial V}\right)_T dV$$

or regarding U as a different function of T and p, i.e.,

$$U = U(T, p)$$

$$dU = \left(\frac{\partial U}{\partial T}\right)_p dT + \left(\frac{\partial U}{\partial p}\right)_T .$$